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The first archaeological case of permanent teeth fusion in Europe

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Declarations of interest: none.

ABSTRACT

Teeth fusion is a developmental anomaly characterized by the union of two, and more rarely, three adjacent teeth. The fusion is caused by the physical pressure between two adjacent teeth during their development due to congenital, inherited, acquired or idiopathic factors. Nowadays, fused teeth occur with a frequency ratio between 0.1% - 1% in permanent dentition and 0.5% - 2.5% in primary dentition, and with an equal distribution between males and females. Fused teeth are a rare clinical finding so there are not standardized clinical protocols and each case should be treated independently. This condition is rare in archaeological populations, likely due to taphonomic processes that cause the lack of information, as well as for the general low occurrence of the defect itself. In the European archaeological literature, there are no reports of two permanent fused teeth so far. Therefore, the present paper represents the first case-study of two fused permanent incisors in the past Europe populations as this anomaly has been recognized in an adult man buried in the Longobard cemetery of Guidizzolo (VI-VII century B.C., northern Italy).

Introduction

Double teeth are a developmental anomaly characterized by the union of at least two adjacent teeth joined by the dentin or pulp and sometimes canals, called also “synodontia” or “twinning” (Sekerci et al., 2011). This developmental anomaly can occur in two different ways: either gemination or fusion. Gemination originates when one tooth bud attempts to split into two, whereas fusion occurs when two tooth buds touch each other and subsequently join (Neves et al., 2002). Gemination and fusion may look identical and a differential diagnosis is difficult to make, especially when a supernumerary tooth is involved (Tritsaroli, 2018). For this reason, the terms ‘double formation’ or ‘double teeth’ are used to indicate both fusion and gemination. However, fusion may be differentiated from gemination by radiographic analysis or the observation of avulsed teeth. It has been proposed that in case of fusion, the crowns are joined by enamel and/or dentine and they have two roots or two root canals merged in a single root. Instead, gemination can generate two crowns and a single root canal and pulp (Sekerci et al., 2011). Fusion can be distinguished in complete or incomplete, depending upon the stage of development of teeth at the time of union (Tritsaroli, 2018). The first type, also called *fusio totalis*, begins before the calcification process and the crown incorporates the features of both teeth involving enamel, dentin, cementum and pulp. In this case the fused teeth appear unite to form an almost normal single tooth, with an enlarged crown. The incomplete type (*fusio partialis*) can be at root level if it occurs after the calcification of the two separate crowns, with or without the involving of the pulp canals (*partialis radicularis*) or can be at crowns level (*partialis coronalis*). In incomplete fusion it is possible to distinguish the outline of the two different crowns, due to the presence of grooves and sulcus (Agarwal et al., 2015; Hülsmann et al., 1997; Rajashekhara et al., 2010; Schuurs & Van Loveren, 2000).

The aetiology is usually searched in congenital, inherited, acquired or idiopathic factors (Kavya et al., 2019). However, other factors may give origin to the double teeth, such as thalidomide embryopathy, hypervitaminosis, fetal alcohol exposure or syndromes such as trisomy 21, orodigitofacial syndrome and Pierre–Robin syndrome (Kavya et al., 2019).

Fusion occurs more often in primary teeth, with particular involvement of mandibular incisors and canines, while gemination and supernumerary teeth are usually found in the maxillary arch (Gurri & Balam, 2018; De Jonge, 1955; Whittington & Durward, 1996). This suggest that the two defects may be under different genetic control and that they result from independent event: a mandibular process of tooth reduction (fusion) and a maxillary process of tooth enlargement (gemination) (Gurri & Balam, 2018; Tritsaroli, 2018). Nowadays, double teeth occur with a frequency ratio between 0.1% - 1% in permanent dentition and 0.5% - 2.5% in primary dentition (Castelino et al., 2015; Wu et al., 2019). This defect has an equal distribution between males and females and it seems to highly spread

among Asian and South American population compared to Caucasian one (Kavya et al., 2019). It is very rare for this defect to bilaterally occur (Tomizawa et al., 2002). Caries or calculus formation can be related due to the presence of deep grooves (Kavya et al., 2019).

Fused teeth are rare in archaeological populations. It is likely due to diagenetic and taphonomic processes that may alter the preservation of human remains, as well as for the general low occurrence of the defect itself. Only few cases have been documented and they have been always pointed out in deciduous dentition (Benazzi et al., 2010; Padgett, 2018; Silva & Silva, 2018; Smith & Wojcinski, 2011; Tritsaroli, 2018), except for a male mummy from an Egyptian site which presents upper permanent incisors fusion (Forshaw, 2019) (Table 1). In this work, we report the first archaeological case of permanent double incisor in Europe.

Case report

During some roadworks in Guidizzolo (Mantova, northern Italy), a Longobard necropolis (VI-VII century B.C.) was discovered and then investigated.

The archaeological excavation led to a total of 93 burials orientated from west to east, on parallel rows, that seemed to reflect Germanic usage. The 93 individuals (34 non-adult, 41 adult and 18 indeterminates) are still under studies at the Laboratory of Osteoarchaeology and Palaeoanthropology of the Department of Cultural Heritage (University of Bologna).

During the osteological analysis of the human remains, a case of union between two permanent mandibular teeth (RI₁ and RI₂) was recognized on the individual n. 58 (Fig. 1). The mandible suffered several postmortem injuries: the break of the right condyle, of the mandibular body and of the fused teeth alveoli, that are avulsed from the mandible. (Fig. 2). Teeth present a generalized deep wear that exposes large areas of dentine and that reaches the root in some cases.

Reabsorption of the lower right second molar (RM₂) proves that it fell before death. Instead, the lower left second molar (LM₂) is not present because it has been sampled for aDNA's analysis. All the other teeth are present except for the third molars that are probably absent for agenesis. The lower first right molar presents an enamel caries on the mesial side.

Anthropological analyses were carried out on the individual n. 58 in order to determine the biological profile. Sex determination based on the sexualization index for the skull (Acsadi & Nemeskeri, 1970) and hip bone morphology (Bruzek, 2002) led to establish that this individual was a man. Estimation of age at death based on the cranial suture obliteration method (Acsadi & Nemeskeri, 1970; Meindl & Lovejoy, 1985), dental wear (Lovejoy, 1985) and the degeneration of the auricular surface (Schmitt, 2005) reveal that the individual died at approximately 35-50 years.

Fused teeth

The double teeth, RI₁ and RI₂ (Fig. 1), were macroscopically analysed under normal light conditions and through radiographies. Both teeth seem to have normal dimensions and the union involves both the upper third of the crowns and the apical part of the roots, while the inter-radicular space was occupied by alveolar bone. A calculus deposit is present in the buccal and lingual side of the interproximal area. In occlusal view, the advanced degree of dental wear shows shared dentine between the two teeth. Thanks to the presence of the entire mandible, we can exclude the presence of supernumerary teeth.

The radiographic examination (Fig. 3) was executed through analogic radiographic system. The X-ray film (DF58, Kodak) was impressed by 0.250 ms X-ray beam set at 70kV and 8mA.

The sample was positioned with the buccal side facing the film, and the x-ray film was then processed using the dedicated reagents. Each dental crown has its own pulp chamber, which seem to be separated and independent. This could mean that the fusion process occurred during the later stage of morph-differentiation (Kavya et al., 2019; Mehta, 2019). Two unconnected roots depart near the cement enamel junction and each root appears to have a single endodontic canal system. In the apical area of the teeth, the two roots have a strict anatomical proximity and, in the last millimetres, they are adherent. Two separated apexes are present. No pathology signs can be detected from the radiograph.

These results lead to identify the fused RI₁ and RI₂ as a case of *partialis coronalis* fusion (Knežević et al., 2002).

Additional age estimation was executed following the method published by Kvaal et. al (1995). Tooth length, root length, pulp and root widths of the lateral mandibular incisor were measured through a digital calibre (INSERIRE MARCA) directly on the X-ray film. Six ratios between the measures were calculated as described by Kvaal and colleagues and the obtained values were implemented in the age estimation regression formulae for lateral lower incisors: $106,6 - 251,7(M) - 61,2(W-L) - 6,0(G)$ (Table 2). The estimated result has been of 31,3 years. This value could suggest that the man could be even a little bit younger than the age estimated through previous anthropological analysis (Kvaal et al., 1995). However, some limitations exist in this technique since several physiological factors could affect the pulpal extension and so the age estimation accuracy.

Conclusion

This paper describes a case of double permanent incisors in an early Medieval population of Northern Italy. The diagnosis is based on macroscopical and radiological examination. Both gemination and fusion were considered for our diagnosis because their causes are more prevalent in primary dentition than in the permanent dentition, with incisors being more affected (Guimarães Cabral et al., 2008). Clearly, the described individual is a case of fusion, involving specifically dental

crowns (*partialis coronalis*). Indeed, the two pulp chambers are separated, the roots are bifurcated in their lower extremity, and the crowns are separated by buccal and lingual grooves. The fusion process occurred during the later stage of the teeth development since only the crowns are merged and the roots are independent. As shown by the dental wear, the dentine of both crowns is confluent. The presence of the groove predisposed the calculus formation which could have led to periodontal damage. However, no sign of decay is detected.

Nowadays, several treatment options have been described in the dental literature (Hulsmann et al., 1997; Malcic & Prpic-Mehicic, 2005; Oliván-Rosas et al., 2004; Stillwell & Coke, 1986). When a *partialis coronalis* fusion occurs, two different treatment approaches can be adopted. If a supernumerary tooth is involved, a surgical section followed by extraction of the supernumerary part is recommended. In that case, if the pulp chambers are connected, root canal treatment of the remaining part is performed. However, when two permanent teeth are fused, like in this case report, crowns' hemi-section and crowns' reshaping could be indicated. Before that, root canal treatment is mandatory for both teeth. Overall, however, fused teeth are a rare clinical finding, so there are not standardized clinical protocols and each clinical case should be treated based on the patient special needs (Tuna et al., 2009).

Clinical cases of double teeth are often described in the modern literature (Castelino et al., 2015; Guimarães Cabral et al., 2008; Kavya et al., 2019; Neves et al., 2002; Sekerci et al., 2011; Tomizawa et al., 2002; Wu et al., 2019), but up to now this anomaly was not recorded in the permanent dentition of past European populations until now. The only documented ancient case involving permanent dentition concerns a 4000 years old Egyptian mummy with upper incisors fusion (Forshaw, 2019). Consequently, as far as we know, this is the first case of fusion of two permanent lower incisors discovered in archaeological context.

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References

- Acsadi G, Nemeskeri J. 1970. *History of human life, span and mortality*. Akadémiai Kiadó.
- Agarwal N, Giri D, Mathur S, Agarwal K. 2015. Synodontia between permanent mandibular central & laterl incisors. *Bangladesh Journal of Dental Research & Education* **5**: 70–72.
- Benazzi S, Buti L, Franzo L, Kullmer O, Winzen O, Gruppioni G. 2010. Report of Three Fused Primary Human Teeth in an Archaeological Material. **485**: 481–485. DOI: 10.1002/oa.1056

- Bruzek J. 2002. A method for visual determination of sex, using the human hip bone. *American Journal of Physical Anthropology* **117**: 157–168.
- Castelino RL, Babu SG, Shetty SR. 2015. Synodontia of permanent mandibular central and lateral incisor- A rare entity. *Balkan Military Medical Review* : 1–3. DOI: 10.5455/bmmr.188435
- Forshaw R. 2019. The Two Brothers: an enlightening study of ancient Egyptian teeth. *British Dental Journal* **226**: 518–524. DOI: 10.1038/s41415-019-0149-2
- Guimarães Cabral LA, Firoozmand LM, Dias Almeida J. 2008. Double teeth in primary dentition: Report of two clinical cases. *Medicina Oral, Patologia Oral y Cirugia Bucal* **13**
- Gurri FD, Balam G. 2018. Inheritance of Bilateral Fusion of the Lower Central and Lateral Incisors: A Pedigree of a Maya Family from Yucatan, Mexico. *Dental Anthropology Journal* **19**: 29–34. DOI: 10.26575/daj.v19i1.117
- Hulsmann M, Bahr R, Grohmann U. 1997. Hemisection and vital treatment of a fused tooth: Literature re- view and case report. *Endodontics & dental traumatology* **13**: 253–258.
- Hülsmann M, Bahr R, Grohmann U. 1997. Hemisection and vital treatment of a fused tooth - Literature review and case report. *Endodontics and Dental Traumatology* **13**: 253–258. DOI: 10.1111/j.1600-9657.1997.tb00051.x
- De Jonge TE. 1955. Beschouwingen over de synodontie. *Ned Tijdschr Tandheelkd* **62**: 828–834.
- Kavya BM, Revanna GM, Girish HC, Murgod S. 2019. Synodontism involving both primary and permanent teeth in a mixed dentition case. *Journal of Medicine, Radiology, Pathology and Surgery* **6**: 12–14. DOI: 10.15713/ins.jmrps.155
- Knežević A, Travan S, Tarle Z, Šutalo J, Janković B, Ciglar I. 2002. Double tooth. *Collegium Antropologicum* **26**: 667–672.
- Kvaal SI, Kolltveit KM, Thomsen IO, Solheim T. 1995. Age estimation of adults from dental radiographs. *Forensic Science International* **74**: 175–185.
- Lovejoy OC. 1985. Dental wear in th Libben population: its functional pattern and role in the determination of adult skeletal age at death. *American Journal of Physical Anthropology* **68**: 47–56.
- Malcic A, Prpic-Mehicic G. 2005. Conservative treatment of fused teeth in permanent dentition. *Acta stomatologica Croatica* **39**: 325–328.
- Mehta V. 2019. Fusion of primary mandibular anterior teeth associated with partial anodontia of

primary and permanent dentition : a case report. *Journal of Dental Health Oral Disorders & Therapy* **3**: 310–312. DOI: 10.15406/jdhodt.2015.03.00090

Meindl RS, Lovejoy OC. 1985. Ectocranial suture closure: a revised method for the determination of skeletal age at death based on the lateral-anterior sutures. *American Journal of Physical Anthropology* **65**: 57–66.

Neves AA, Neves NLA, Farinhas JA. 2002. Bilateral fusion of permanent mandibular incisors: A case report. *International journal of paediatric dentistry* **12**: 61–65.

Olivan-Rosas G, Lopez-Jimenez J, Gimenez-Prats MJ, Piqueras-Hernandez M. 2004. Considerations and differences in the treatment of a fused tooth. *Medicina Oral Patologia Oral y Cirugia Bucal* **9**: 224–228.

Padgett BD. 2018. Triple Fusion in the Primary Dentition from Law 's Site , Alabama (1MS100): A Case Report DOI: 10.26575/daj.v23i1.67

Rajashekhara BS, Dave B, Manjunatha BS, Poonacha KS, Sujana SG. 2010. Bilateral fusion of primary mandibular lateral incisors and canines: a report of a rare case TT - Fusão bilateral de dentes decíduos incisivo e canino inferior: relato de um caso raro. *Rev. odonto ciênc* **25**: 427–429.

Schmitt A. 2005. A new method to assess adult age at death from the iliac sacro-pelvic surface. *Bulletins et Mémoires de la Société d'Anthropologie de Paris* **17**

Schuurs AHB, Van Loveren C. 2000. Double teeth: Review of the literature. *Journal of Dentistry for Children* **67**: 313–325.

Sekerci A, Sisman Y, Yasa Y, Sahman H, Ekizer A. 2011. Prevalence of fusion and gemination in permanent teeth in Cappadocia region in Turkey. *Pakistan Oral & Dental Journal* **31**: 17–22.

Silva AM, Silva AL. 2018. Unilateral Fusion of Two Primary Mandibular Teeth: Report of a Portuguese Archeological Case. *Dental Anthropology Journal* **20**: 16–18. DOI: 10.26575/daj.v20i1.107

Smith MO, Wojcinski MC. 2011. Anomalous double-crowned primary teeth from Pre-Columbian Tennessee: A meta-analysis of hunter-gatherer and agriculturalist samples. *International Journal of Paleopathology* **1**: 173–183. DOI: 10.1016/j.ijpp.2012.02.008

Stillwell KD, Coke JM. 1986. Bilateral fusion of the maxillary central incisors to supernumerary teeth: report of case. *Journal of the American Dental Association* **112**: 62–64.

Tomizawa M, Shimizu A, Hayashi S, Noda T. 2002. Bilateral maxillary fused primary incisors

accompanied by succedaneous supernumerary teeth: report of a case. *International journal of paediatric dentistry / the British Paedodontic Society [and] the International Association of Dentistry for Children* **12**: 223–227. DOI: 10.1046/j.1365-263X.2002.00351.x

Tritsaroli P. 2018. A Case of Dental Fusion in Primary Dentition from Late Bronze Age Greece. *Balkan Journal of Dental Medicine*

Tuna EB, Yildirim M, Seymen F, Gencay K, Ozgen M. 2009. Fused teeth: a review of the treatment options. *Journal of Dentistry for Children* **76**: 109–116.

Whittington BR, Durward CS. 1996. Survey of anomalies in primary teeth and their correlation with the permanent dentition. *New Zealand Dental Journal* **94**: 4–8.

Wu L, Shi B, Zhang R, Liu J. 2019. Root canal therapy of a supernumerary tooth fused with maxillary second molar: a case report. *International Journal of Clinical and Experimental Medicine* **12**: 4422–4427.

REFERENCE	TEETH INVOLVED	AGE AT DEATH	SITE	CHRONOLOGY
Forshaw, 2019	L1 ¹ and L1 ²	40 years	Deir Rifeh – Cairo (Egypt)	1985 – 1773 BC
Tritsaroli, 2018	RdI ₁ and RdI ₂	18 (± 6) months old	Rema Xydiias - Platamonas (Greece)	Late Bronze Age
Silva & Silva, 2018	LdI ₂ and Ld _c	3-4 years	Miroiço - Sintra (Portugal)	2nd – 4th century AD
Padget, 2010	LdI ¹ , LdI ² , Ld ^c	9 months old	Law's Site – Alabama (USA)	1540 – 1715 AD
Benazzi et al., 2010	RdI ¹ and RdI ²	5 years	S. Martino in Rivosecco - Borgotaro (Parma, northern Italy)	14th – 18th century AD
Smith & Wojcinski, 2011	RdI ₂ and Rd _c	5-6 years	Cherry - Tennessee (USA)	2500-1000 BC
	RdI ₁ and RdI ₂	3.5-4.5 years	Cherry - Tennessee (USA)	
	RdI ₂ and Rd _c	0.5-0.75 years	Oak View Landing - Tennessee (USA)	
	LdI ₂ and Ld _c	4.5-6 years	Kays Landing - Tennessee (USA)	
	LdI ₁ and LdI ₂ RdI ₂ and Rd _c	1 years	Toqua - Tennessee (USA)	1300-1550 AD
	LdI ₂ and Ld _c	1.5-2 years	Toqua - Tennessee (USA)	
	LdI ₁ and RdI ₁	2-2.5 years	Toqua - Tennessee (USA)	
	RdI ₁ and RdI ₂	1-1.5 years	Toqua - Tennessee (USA)	
	LdI ₂ and Ld _c RdI ₂ and Rd _c RdI ² and Rd ^c LdI ¹ and LdI ²	3-4 years	Citico - Tennessee (USA)	

Table 1. Archaeological case of fused incisors found in literature.

MEASURES (mm)		RATIOS	
Tooth length	17,19	P (pulp length/root length)	1,44
Pulp length	14,03	T (tooth length/root length)	0,57
Root length	9,72	R (pulp length/tooth length)	0,82
Root width in A	3,51	A (pulp width/root width in A)	0,18
Root width in B	2,96	B (pulp width/root width in B)	0,11
Root width in C	3,17	C (pulp width/root width in C)	0,06
Pulp width in A	0,63	M (mean value of all ratios)	0,53
Pulp width in B	0,32	W (mean value of width ratios from levels B and C)	0,09
Pulp width in C	0,20	L (mean value of the length ratios P and R)	1,13

Table 2. Measures executed on the X-ray plate and ratios (Kvaal et al., 1995). A: enamel-cementum junction; B: midpoint between level C and A; C: mid-root level. Estimated years (lateral incisor) regression formulae = $106,6 - 251,7(M) - 61,2(W-L) - 6,0(G)$ (where G: male = 1, female = 0).

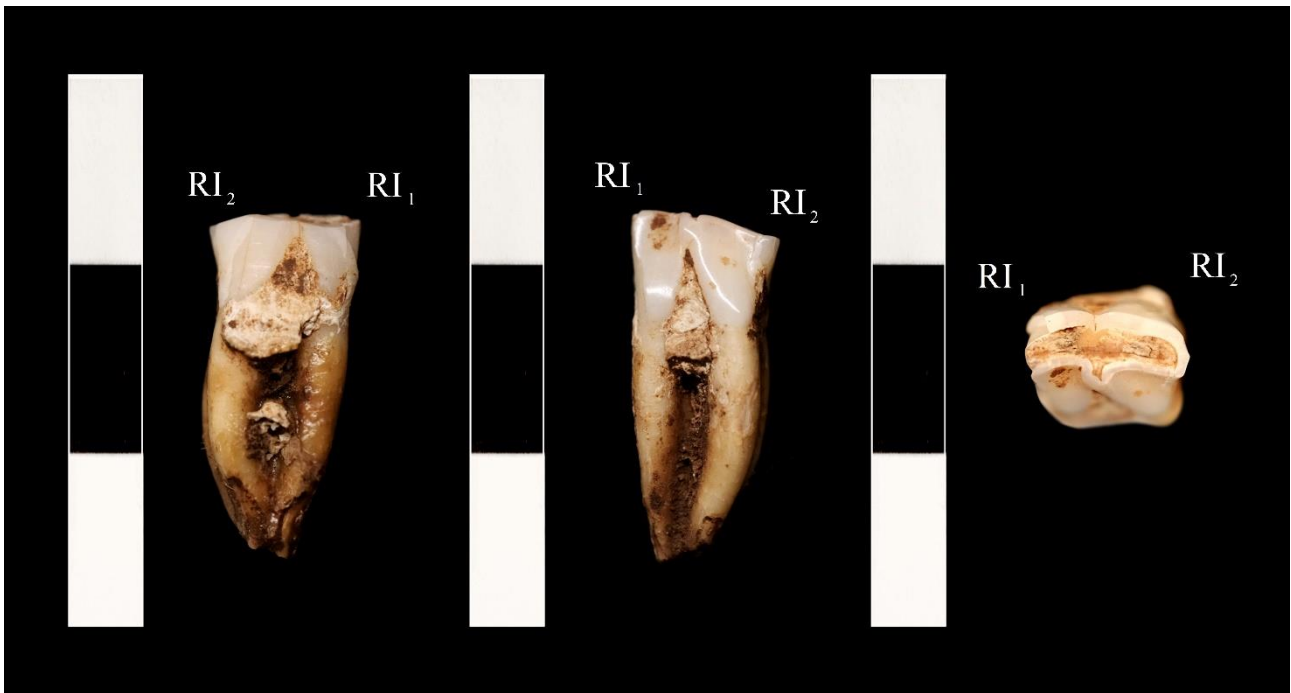


Figure 1 Buccal view (on the left), lingual view (in the center) and occlusal view (on the right) of the two permanent fused teeth.



Figure 2 Occlusal view of the mandibular dentition. Fused permanent teeth are the first and the second right lower incisor which are not in place.

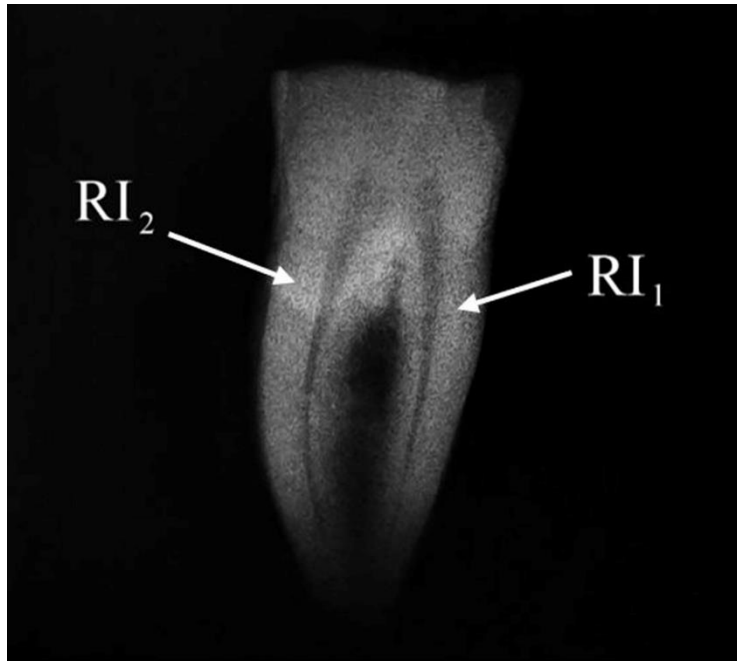


Figure 3 Radiograph of the two fused permanent teeth RI₁ and RI₂ (buccal view).